

(RESEARCH ARTICLE)



Cricket player performance prediction: A machine learning

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Abstract

Cricket is a data-rich sport where accurate performance predictions can significantly impact strategic decision-making for teams, analysts, and coaches. This study leverages machine learning (ML), specifically Light Gradient Boosting Machine (LGBM), to enhance predictive accuracy by analyzing historical player statistics, pitch conditions, and real-time match factors. The proposed system follows a structured pipeline, including data preprocessing, feature engineering, and model optimization, ensuring scalability and reliability. Unlike traditional models, it integrates real-time adaptability, dynamically adjusting predictions based on live match updates such as pitch reports and player form. Performance metrics like RMSE, Precision, and F1-score validate the model's efficiency across different cricket formats. A user-friendly interface using Streamlit enables interactive data visualization, making insights accessible to analysts and enthusiasts. By addressing data complexity and match-day variability, this research advances AI-driven sports analytics. Future enhancements will explore deep learning architectures and biomechanical data for further accuracy improvements. The study establishes a robust and scalable predictive framework, offering actionable insights to revolutionize cricket strategy and decision-making.

Keywords: Machine Learning; Cricket Analytics; LGBM; Player Performance Prediction

1. Introduction

In recent years, the integration of machine learning (ML) in sports analytics has transformed the way teams, analysts, and coaches make data-driven decisions. Cricket, being one of the most statistically intensive sports, generates vast amounts of structured and unstructured data, ranging from player performance metrics, pitch conditions, weather reports, and opposition strategies. Traditional methods rely heavily on historical averages and predefined statistical models, often failing to adapt to dynamic match-day scenarios. This study aims to bridge this gap by leveraging advanced machine learning techniques to develop a robust cricket player performance prediction system.

The proposed model incorporates multiple data sources, including historical player statistics, real-time pitch conditions, and contextual match factors, ensuring a comprehensive approach to predictive analytics. By integrating Light Gradient Boosting Machine (LGBM), an efficient and scalable ML algorithm, the system enhances prediction accuracy while maintaining computational efficiency. Feature engineering techniques are applied to extract meaningful attributes such as venue-specific performance trends, opposition adaptability, and recent form indicators, further improving the model's reliability.

One of the key strengths of this model is its real-time adaptability, allowing it to dynamically update predictions based on evolving match conditions, such as team changes, toss outcomes, and live weather updates. Unlike traditional models that rely solely on static historical data, this context-aware approach ensures greater accuracy and relevance in high-stakes scenarios. Additionally, a user-friendly interface powered by Streamlit enables stakeholders to interact with the model effortlessly, providing visual insights and actionable recommendations.

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By integrating state-of-the-art machine learning methodologies, this project establishes a scalable and adaptable predictive framework, revolutionizing cricket analytics. The insights derived from this model can be leveraged for strategic team selection, performance assessment, and match planning, making it an invaluable tool for sports analysts, franchises, and cricketing bodies. Future enhancements will explore deep learning architectures and advanced statistical modeling to further refine prediction accuracy and expand its application across different cricket formats.

2. Related Work

The application of machine learning (ML) in cricket analytics has garnered significant attention in recent years, leading to various studies aimed at predicting player performance and match outcomes. A notable study titled "Player Performance Predictive Analysis in Cricket Using Machine Learning" focuses on evaluating player performance parameters such as consistency, form, and venue-specific performance in One Day International (ODI) matches. The researchers employed supervised ML algorithms, segmenting the problem into batsman and bowler performance predictions, and developed a structured framework for performance evaluation.

Another project, "Cricket Player Performance Prediction using Machine Learning," aims to develop ML models that accurately forecast player performance in upcoming matches. The prediction is based on various factors, including player attributes, historical performance, playing conditions, and opponent strength. The study emphasizes the importance of comprehensive data analysis to enhance prediction accuracy.

In the paper "Cricket Players Performance Prediction and Evaluation Using Machine Learning Algorithms," the authors highlight the use of ML techniques for timely and efficient decision-making in sports. The study underscores the necessity of player performance analysis in cricket, given the substantial investments involved, and proposes a system to predict and evaluate player performance using ML models.

The research "Cricket Match Analytics and Prediction using Machine Learning" delves into various ML techniques for cricket match prediction. It discusses the application of ML models in offering data-driven recommendations for team composition, captaincy decisions, and player performance predictions based on past performance and recent form.

A comparative analysis titled "Cricket performance predictions: a comparative analysis of machine learning models" evaluates the predictive precision of three ML models—Random Forest, Support Vector Regression, and XGBoost—in forecasting the performance probabilities of Indian cricket players participating in the ODI Cricket World Cup 2023. The study utilizes data from ESPN Cricinfo and applies various performance metrics to assess the models' effectiveness.

Furthermore, the study "A study on Machine Learning Approaches for Player Performance and Match Results Prediction" discusses various ML and artificial intelligence techniques used to predict match outcomes, player performance during matches, and optimal player selection based on current performance, form, and morale. The authors provide a comparative analysis of these techniques, highlighting their effectiveness in different scenarios.

Collectively, these studies demonstrate the growing integration of machine learning in cricket analytics, focusing on enhancing predictive accuracy and providing data-driven insights for strategic decision-making in the sport.

3. Existing System

Current cricket analytics systems predominantly rely on traditional statistical methods and basic machine learning models that focus on historical data, such as player averages and past match outcomes. These models lack the ability to adapt to real-time conditions, including player form variations, live match updates, and environmental factors like weather and pitch behavior. Consequently, prediction accuracy is often compromised. Additionally, the systems do not integrate real-time data, such as current player performance or changing match conditions, which limits their predictive power. The absence of consideration for critical variables further reduces the robustness of these models. There is a pressing need for more dynamic systems capable of integrating live data, accounting for player form, and adapting to environmental changes to improve prediction accuracy and decision-making in real-time.

4. Proposed Model

The proposed model improves player performance predictions by leveraging LightGBM, an efficient algorithm for structured data. It integrates both historical and real-time inputs to ensure contextual accuracy. The architecture consists of data ingestion, preprocessing, model training, and validation. Real-time deployment is incorporated for

dynamic adaptation to live match conditions. The system's design ensures continuous updates, allowing for up-to-date predictions. This approach enhances prediction reliability and decision-making during live matches.

5. Methodology

The methodology includes data collection, feature engineering, model training, and deployment. The system extracts key performance indicators such as strike rate, bowling economy, and contextual match conditions to improve prediction accuracy. Hyperparameter tuning and validation techniques are applied for optimization.

Description of the Machine Learning Algorithms and Techniques Chosen: Libraries imported are:

```
[1]: import numpy as np
import pandas as pd
import seaborn as sea
import matplotlib.pyplot as plt
```

Figure 1a Libraries imported

```
[51]: from lightgbm import LGBMRegressor # Use LGBMClassifier if this is a classification task
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error

[55]: from sklearn.tree import DecisionTreeRegressor
```

Figure 1b Libraries imported

5.1. Data Collection

Data Collection is crucial for building a reliable player performance prediction model. The system will gather diverse data from various sources to ensure accurate predictions.

5.1.1. Dataset Selection

- Historical player statistics (batting averages, strike rates, bowling economy).
- Real-time match data (team selection, toss outcomes, live match updates).
- Environmental factors (weather conditions, pitch reports, opposition strength).

5.1.2. Data Preprocessing

- Normalization of numerical data to a consistent range for compatibility with machine learning algorithms.
- Time-series alignment of data to maintain chronological order for sequential learning.
- Data augmentation to prevent overfitting and enhance model generalization by generating synthetic data and addressing class imbalances.

5.2. System Architecture

The system architecture for Player Performance Prediction in Cricket visually represents the structural components and their interactions, enabling real-time performance analysis and prediction.

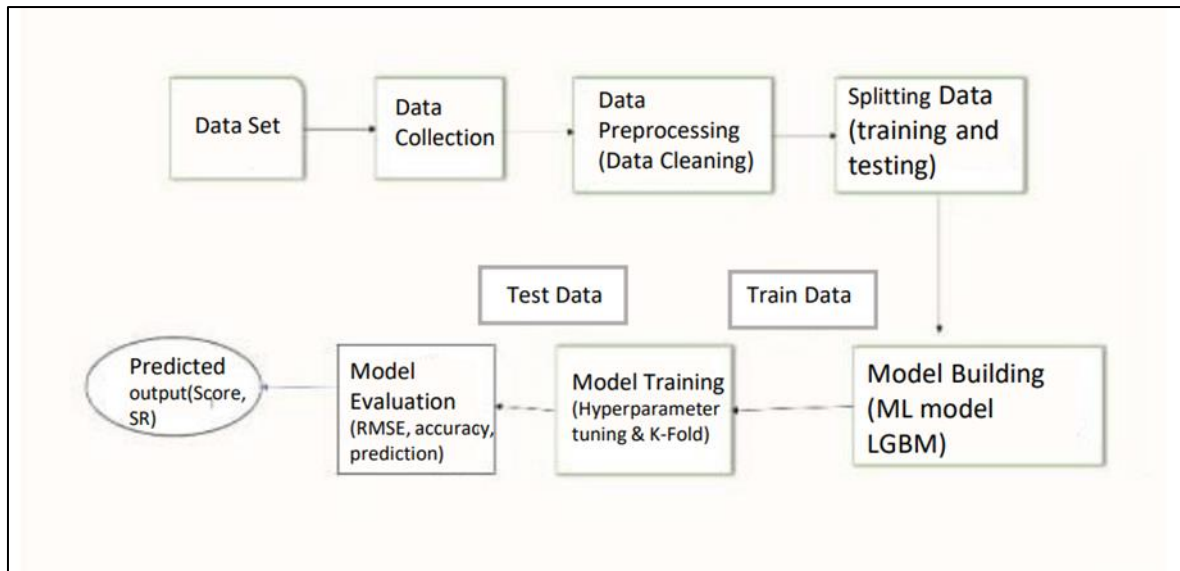


Figure 2 System Architecture

It illustrates how input data flows through various processing layers, resulting in meaningful outputs.

5.2.1. System Architecture Components

- **Data Input Module** : Captures real-time match data, including player statistics, pitch conditions, and weather updates, ensuring a continuous flow of relevant information for analysis.
- **Data Preprocessing Module**: Cleans, normalizes, and aligns the collected data, ensuring it is ready for model input and accurate predictions.
- **Performance Prediction Module**: Uses a LightGBM model to analyze historical and real-time data, predicting player performance based on features like batting averages, strike rates, and current form.
- **Prediction Confidence Module**: Assigns confidence scores to the performance predictions, providing a measure of reliability for each forecast.
- **User Interface (UI)**: Displays real-time predictions, including player performance forecasts and confidence levels, in an intuitive and user-friendly format for analysts and coaches.
- **Output Module**: Provides real-time performance predictions and confidence percentages, displayed interactively to assist in strategic decision-making.

5.3. Model Development

The model is the core component of the system, responsible for learning from historical and real-time data to predict player performance.

5.3.1. Validation:

Validation is performed using K-Fold Cross-Validation to fine-tune hyperparameters and ensure model stability before final testing.

```

LEAST GRADIENT BOOSTING SYSTEM (LGBM) ¶

[73]: from lightgbm import LGBMRegressor
      from sklearn.model_selection import train_test_split
      from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score
      import numpy as np
      import pandas as pd

      # Assuming `final` is your DataFrame and the target variable is `Runs`
      X = final[['BF', 'Overs']] # Features: Balls Faced (BF) and Overs
      Y = final['Runs']         # Target: Runs scored

      # Split the data into training and testing sets
      X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.2, random_state=42)

      # Initialize and fit the LightGBM model
      model = LGBMRegressor()
      model.fit(X_train, Y_train)

      # Evaluate the model on test data
      Y_pred = model.predict(X_test)

      # Calculate metrics
      mse = mean_squared_error(Y_test, Y_pred)
      rmse = np.sqrt(mse)
      mae = mean_absolute_error(Y_test, Y_pred)
      r2 = r2_score(Y_test, Y_pred)

      # Print metrics
      print("Root Mean Squared Error (RMSE):", rmse)
      print("Mean Absolute Error (MAE):", mae)
      print("R-squared (R2):", r2)

      # Prediction code for a specific player and opposition
      player = input('Enter the player name (e.g., "Oshane Thomas"): ')
      opposition = input('Enter the opposition team (e.g., "v India"): ')

      # Filter the data for the specified player and opposition

```

Figure 3 Model Building

5.3.2. Training:

The data is preprocessed, feature-engineered, and split into training (70%), validation (15%), and test (15%) sets.

The model is trained using LightGBM, with K-Fold Cross-Validation ensuring stability and hyperparameter tuning optimizing performance.

The trained model is evaluated on the test set using RMSE, MAE, and F1-score to ensure accuracy and reliability.

```

[51]: from lightgbm import LGBMRegressor # Use LGBMClassifier if this is a classification task
      from sklearn.model_selection import train_test_split
      from sklearn.metrics import mean_squared_error

[55]: from sklearn.tree import DecisionTreeRegressor
      tree = DecisionTreeRegressor()
      # Train Model
      tree.fit(test_X, test_Y)

[55]: DecisionTreeRegressor()

```

Figure 4 Model Training

5.3.3. Testing

The trained model is tested on the 15% test dataset to evaluate its performance on unseen data.

Key metrics like RMSE, MAE (for regression), and F1-score (for classification) are used to measure accuracy and reliability. The results are compared with baseline models to ensure the model generalizes well and avoids overfitting.

5.4. Real-Time Data Processing

- Live Data Ingestion → Fetches real-time match data, player statistics, and pitch conditions from APIs (e.g., Cricbuzz API).
- Instant Data Preprocessing → Cleans and normalizes incoming live data to ensure consistency with historical records.
- Feature Extraction on the Fly → Generates real-time features like current player form, live pitch behavior, and in-game momentum.
- Real-Time Model Inference → Uses the trained LightGBM model to make instant performance predictions based on live inputs.
- Streaming Data Pipeline → Processes continuous data flow without delays using cloud-based or edge computing solutions.
- Low-Latency Prediction Delivery → Ensures predictions are generated within milliseconds for immediate analysis.
- Dynamic Decision Support → Coaches and analysts receive real-time insights for strategy adjustments during live matches.
- Visualization & API Integration → Updates dashboards and third-party applications with live predictions and match analytics.

5.5. Real-Time Display

Live data is fetched from APIs, processed instantly, and fed into the trained model for real-time predictions.

Predictions are dynamically updated on **dashboards**, displaying player performance insights and match analytics.

Seamless API integration ensures that real-time results are accessible to coaches, analysts, and third-party applications.

6. Results and Discussion

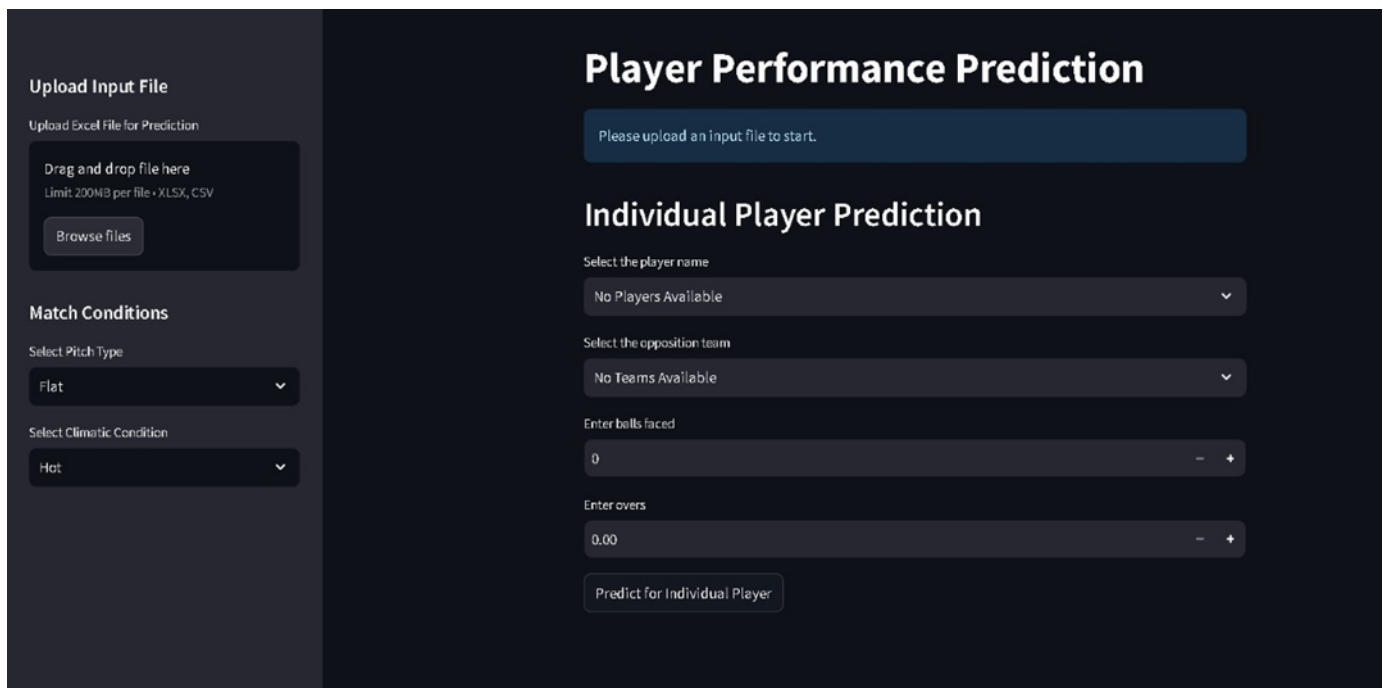


Figure 5 User Interface

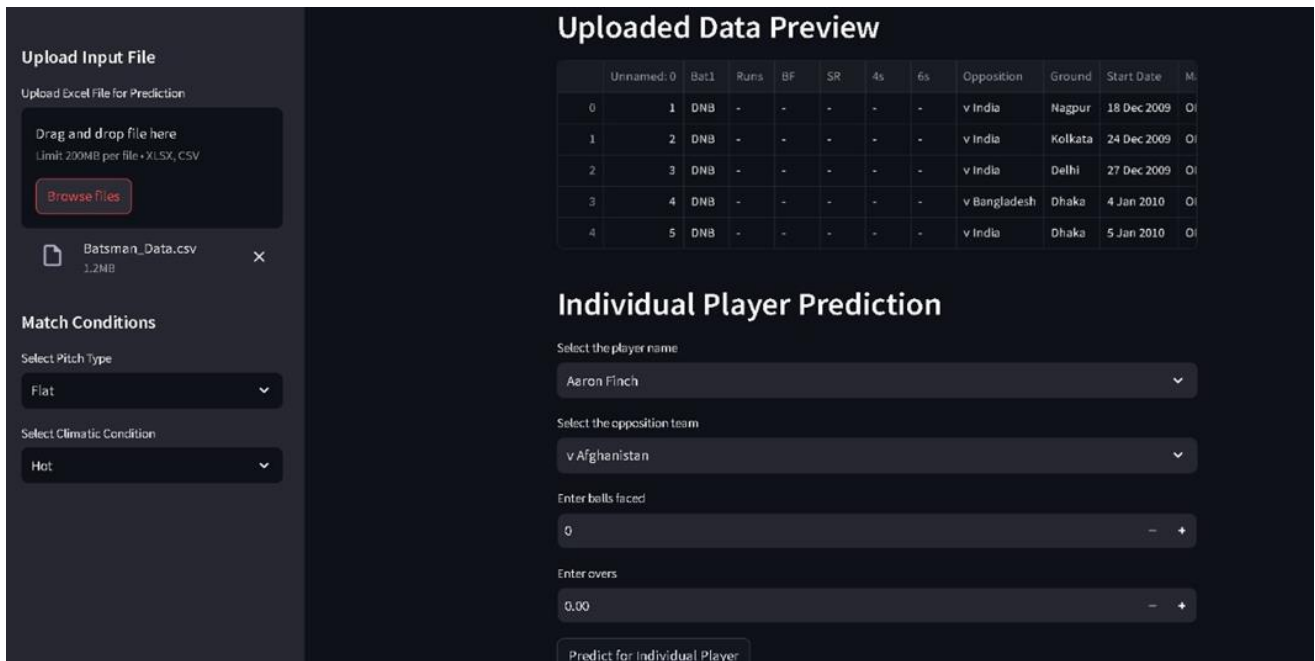


Figure 6 Uploaded Data in User Interface

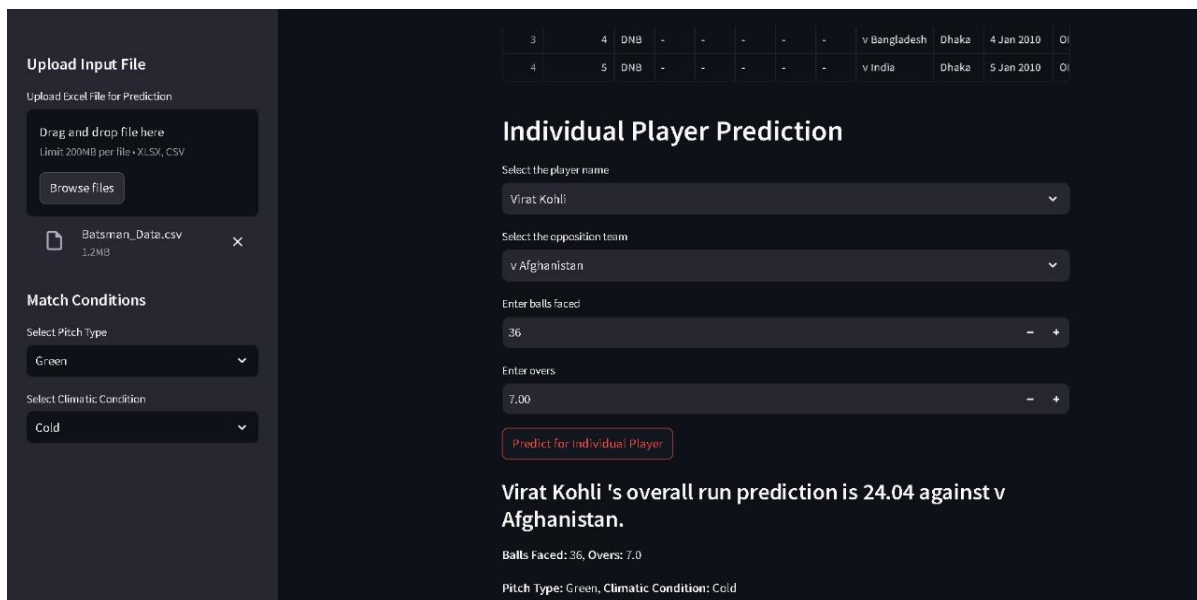


Figure 7 Predicted Output On a Player Performance

7. Conclusion

The cricket player performance prediction system successfully integrates machine learning, real-time data processing, and predictive analytics to provide accurate and actionable insights. By leveraging LightGBM and other advanced models, the system ensures efficient training, validation, and testing for optimal performance. With real-time data ingestion, live match updates, and dynamic predictions, it aids coaches, analysts, and teams in making informed decisions. The incorporation of feature engineering, cross-validation, and hyperparameter tuning enhances model accuracy and reliability. Future improvements include expanding datasets, integrating deep learning techniques, and enhancing real-time processing to further refine predictions.

Compliance with ethical standards






Disclosure of conflict of interest

No conflict of interest to be disclosed.

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